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ATOMIC WEAPONS RESEARCH ESTABLISHMENT

AWRE REPORT No. T 4/65

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OPERATION ANTLER

Air Shock Measurements

R. G. Turner

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AUTHOR
SUBJECT
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ABSCT. ✓

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A.W.R.E.,
Aldermaston, Berks.

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March 1965

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Air Shock Measurements

R. G. Turner

Summary

See Page 2.

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Summary

On Operation Antler measurements were made of the shock overpressure/time relationship at sites down the main instrument lane, similar measurements at a few other isolated sites, and peak free air shock overpressure by a smoke rocket technique.

Three types of instrument were used. Two gave a pressure/time history of the shock wave at the recording site; the third, a measurement of the peak overpressure at the recording site.

The pressure/distance data for the precursor-free regions of the main instrument lanes have been compared with Foulness small charge data to give estimated total energy yields of:-

Round 1: 0.65 ± 0.05 kilotons

Round 2: 6.86 ± 0.36 kilotons

Round 3: 17.9 ± 0.9 kilotons.

Time of arrival data, positive phase duration and positive phase impulse data are included. Canadian measurements of the free air shock using a smoke rocket trail technique are reported elsewhere.

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1. INTRODUCTION

Operation Antler at Maralinga comprised the detonation of three kiloton yield weapons. Rounds 1 and 2 were 100 ft tower bursts at Tadje and Biak sites respectively. Round 3 was a balloon supported shot at approximately 1 000 ft above site Taranaki.

The main aim of the air shock measurements was to provide an estimate of weapon yield. To this end the measurement sites were placed in the main instrument lanes, graded level tracks 60 ft wide bulldozed free of obstructions with a surface of fine red sand running radially from weapon ground zero. The instrument sites were located at predicted precursor-free distances with ground ranges increasing in geometrical progression. This gave a good distribution of points on a log-log plot of peak overpressure against distance as on these scales the pressure/distance curve was approximately linear. It also had the advantage that any large last minute change in the predicted yield of the weapon only meant the addition of extra sites at one end of the line and not a complete re-siting.

The AG Group consisted of nine members. From the Foulness Division of the Atomic Weapons Research Establishment were D. E. J. Samuels, Group Leader, R. G. Turner, T. Whiteside, A. G. Hunt and L. F. Johns. The other four were from the staff of the Suffield Experimental Establishment of the National Defence Research Board, Canada.

2. OBJECT OF THE MEASUREMENTS

The air and ground shock team for Operation Antler performed the following tasks:-

AG.1(a): Measurement of overpressure/time variation at the manned sites in forward area (North Base, Iria and Roadside) using mechanical diaphragm gauges (T. Whiteside).

AG.1(b): Measurement of overpressure/time/distance variation of the blast wave in the region 15 to 2.5 p.s.i. down the main instrument lanes using FMT recorders (R. G. Turner and L. F. Johns).

AG.1(c): Measurement of peak overpressure/distance variation in the range 8 to 2.5 p.s.i. down the main instrument lanes using collapsible tubes (T. Whiteside).

AG.4: On Round 2 only - measurement of transient ground acceleration/time/distance and velocity/time/distance variations (A. G. Hunt).

AG.7: Determination of the velocity/distance variation of the free air shock wave by high speed photography (100 frames/s) of the shock front against a grid of smoke rocket trails (Canadian team).

AG.8: On operational test of weapon power meters on Rounds 2 and 3. These are robust, direct reading, mechanical peak pressure gauges, accurate to about ± 10% and are intended to give a quick estimate of the order of magnitude of the weapon if the distance from the explosion is known (T. Whiteside).

AG.9: An investigation of precursor effects on Round 3. Eight light vehicles, Austin Champs, were exposed between 1 150 and 3 100 ft from ground zero in the target response area. Six were placed head-on and two side-on. The FMT recorder line (AG.1(b)) was extended inwards to 1 360 ft on the main instrument lane, four extra sites being installed. To check on the radial symmetry of the precursor phenomena, two FMT sites were installed in the target response area. These were operated by flash switches. This task was performed in co-operation with Target Response (TR) Group.

This report deals with items AG.1(a), 1(b) and 1(c), and includes the pressure measurements obtained for AG.9. For items AG.4 and AG.8 see references [1] and [2] respectively.

3. APPARATUS AND METHOD

3.1 AG.1(a) was accomplished with FC.1 battery powered diaphragm gauges which utilize a diaphragm-lever-stylus system writing on moving celluloid film to produce an overpressure/time history of the blast wave. The diaphragms in this instance were very thin with a 1 p.s.i. nominal sensitivity. In addition for Rounds 2 and 3,

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1. A. G. Hunt: "Operation Antler. Measurement of Ground Shock". AWRE Report No. T42/58

2. F. H. Grover, G. F. Harwood and A. C. Purdie: "A Weapon Power Meter for Civil Defence Purposes". AWRE Report No. E3/59

an FMT (Frequency Modulated Tape) recorder (which has a rather better frequency response) was used at North Base. The pressure transducers were mounted on suitable posts and the instruments were started either by flash switch operation or by hand.

3.2 AG.1(b) was accomplished using FMT recorders. These utilized a pressure sensitive variable inductance transducer which was mounted in a streamlined baffle. This frequency modulated an oscillator for recording on magnetic tape. The tape recorder was battery powered and shock mounted in a pressure tight vessel at the site of the measurement. The recorders were started by a cabled time sequence signal at 30 s prior to time zero. The records were analysed by subsequent replay, demodulation, and photographic recording [1].

3.3 Task AG.1(c). This was a "safeguard" measurement by which it is meant that it was not dependent on any external power or starting sequence for its successful operation. The "instrument" consisted of nine collapsible toothpaste tubes. These are empty, sealed (except for a small leak) and mounted in a streamlined baffle. The size of the leak was such that the leak rate was slow with respect to the actual crushing of the tube by the shock front but fast with respect to subsequent pressure variations in the blast wave, thus preventing any recovery. The degree of crushing (which varied with peak overpressure) was determined by measuring the change of buoyancy in water of the sealed tubes, with a chain balance. The gauges were calibrated in the atomic blast simulator (ABS), a shock tube with a large reservoir giving a blast wave of similar shape and positive duration to a low yield atomic weapon.

4. RESULTS

The results are set out in Tables 1 - 6 and Figures 1 - 14. The observations were corrected first of all for wind. The distances, pressures, times and impulses were then reduced to standard sea level atmosphere conditions of 1013 mb pressure and 15°C temperature by the use of the modified scaling laws [2]. A correction can also be applied for the variation of the speed of sound with humidity but it was

1. W. G. P. Lamb: "A Self-Contained Electronic Blast Pressure Recorder Using an Inductive Transducer Recording on Magnetic Tape". AWRE Report No. O-1/59

2. "The Effects of Atomic Weapons". USAEC (1962)

insignificant for these rounds. The results in the tables are the standardized data. The observed values may be obtained by dividing the standard data by the correction factors given.

The peak pressure data were then compared to small scale height of burst data [1] by curve fitting using the method of least squares. It is assumed that 45% of the total energy went into the blast wave.

4.1 Rounds 1, 2 and 3. AG.1(a) (Distant Recording, Diaphragm and FMT Gauges)

While all gauges ran satisfactorily including the FMT recorder added on Rounds 2 and 3, the sensitivity was not always sufficient at the more distant sites of Iria and Roadside to give an interpretable result (Table 1). Photographic reproductions of the FMT records are shown in Figures 11 and 14.

4.2 Round 1. AG.1(b) (FMT Main Gauge Line)

No records were obtained from the FMT recorders due to a time sequencing failure. This was caused by a battery switch developing a high contact resistance some time between the last pre-evacuation check at F - 4½ hours and time zero. For subsequent rounds all switches on the time sequence unit were wired out of circuit and two completely independent time sequence units employed, each operating alternate recorders down the instrument lane. One item of information provided by the gauge baffles on this round was the extent of the precursor. The gauge baffle at 840 ft from ground zero was sand blasted, that at 920 ft was slightly roughened at the nose, while that at 1030 ft was unmarked. This is in agreement with the high speed cine record which suggests that the main Mach wave overtook the precursor at about 1000 ft from ground zero.

4.3 Round 1. AG.1(c) (Collapsible Tubes Main Gauge Line)

Table 2 and Figure 1 show the peak overpressure results from the collapsible tubes for this round corrected for wind and reduced to standard atmosphere conditions. The curves marked 0.6

1. Winifred E. Worsfold: "The Variation of Pressure on the Ground with Height of Burst, Series II. Part I: The Variation of Peak Pressure". AWRE Report No. 0-42/57

and 0.7 kilotons have been derived from small charge height-of-burst data [1] modified by a microscale investigation of the effect of the Tadje terrain on the blast wave. The vertical extension of the points represents the probable error in calibration of the toothpaste tubes while the horizontal extension indicates the uncertainty in wind correction (direction 220° ± 10°, speed 15 ± 10 knots). From these results the yield is estimated to be 0.65 ± 0.05 kilotons total energy.

4.4 Round 2. AG.1(b) and AG.1(c) (FMT Gauges, Collapsible Tubes, Main Gauge Line)

A high percentage of successful records was obtained. The FMT records are reproduced in Figures 10 and 11. The results are set out in Tables 3 and 4 and Figures 2 to 5. The rocket trail measurements suggested a precursor wave was present out to 1 650 ft from ground zero. The nearest FMT site was at 1 650 ft and showed no sign either of sandblasting or slow pressure rise on the record. Despite this the toothpaste tube results seem to be generally low. The solid curve on Figure 2 has been fitted to the FMT results by the method of least squares and gives a yield of 6.86 ± 0.36 kilotons total energy.

4.5 Round 3. AG.1(b) and AG.1(c) (FMT Gauges, Collapsible Tubes, Main Gauge Line)

Here again a high percentage of successful records was obtained, the results are set out in Tables 5 and 6 and Figures 6 to 9. The FMT records are reproduced in Figures 12 to 14. On this round a full precursor developed which sandblasted the surface of the gauge baffles out to 2 700 ft from ground zero. The pressure record was still not a shock front at site 501 (3 000 ft) (Figure 13). Also the toothpaste tubes did not compare at all favourably with the FMT results nearer than 6 000 ft.

There were several interesting features on this round, one of which was the marked effect of the ridge at 1 700 ft (Figure 16). The record at 2 080 ft was very unreliable (a fault occurred at time zero). However, Figure 6 does seem to show a general depression of shock overpressures in the region 1 700 - 2 700 ft enhancing the

1. Winifred E. Worsfold: "The Variation of Pressure on the Ground with Height of Burst, Series II. Part I: The Variation of Peak Pressure". AWRE Report No. 0-42/57

precursor depression. The sites in the target response area do not fit in well with the main instrument lane results probably because of the rather flatter terrain. The pressure/distance data for the FMT sites beyond 3000 ft from ground zero have been fitted to the small scale data as previously and give a yield of 17.9 ± 0.9 kilotons total energy. Also plotted on Figure 6 is the pressure/distance curve for average surface conditions taken from American data [1] for a yield of 18.6 kilotons.

The second thing of interest is the second "shock" occurring during the positive phase. This has been observed on only one previous occasion at Maralinga and that was Round 3 of Operation Buffalo, an air burst at a scaled height (to 1 kiloton) of 350 ft. Figure 9 shows the times of arrival of the first and second shocks for Antler 3 together with the same data for Buffalo 3 scaled up to 17.9 kilotons total energy. The discrepancy at short ground ranges is probably because of a small difference in the scaled height of burst for the two rounds. At the more distant stations where the slant range approximates to the ground range the two rounds agree almost exactly. The pressure change in the second "shock" has been plotted on Figure 6. It appears to be about 10% of the main pressure pulse in magnitude although in the precursor region the results are rather scattered.

The third interesting feature of this round was a steepening of the pressure pulse at the end of the negative phase (not shown in the reproduction). This is to be expected from a rising pressure pulse and was observed to form a shock on Buffalo 3. It was this "3rd shock" which was heard at North Base on Antler 3, being 0.12 p.s.i. magnitude at that site. As previously, the time of arrival of this event at distant sites compares very well with that obtained by scaling from Buffalo 3. They differ by about 0.5%.

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1. Capabilities of Atomic Weapons. (1957) TM23 - 200

TABLE 1

OPERATION ANTLER. TASK AG.1(a). SUMMARY OF RESULTS

ROUND 1

Measurement Site	North Base	Iria	Roadside
Distance from Ground Zero, ft	20200	30200	42000
Peak Overpressure, p.s.i.	0.1	Very small	Very small
Pulse Shape	Rounded	-	-
Positive Phase Duration, s	0.76	-	-

ROUND 2

Measurement Site	North Base (Mean of FC1 and FMT)	Iria	Roadside
Distance from Ground Zero, ft	21100	29600	44700
Peak Overpressure, p.s.i.	0.29	0.12	Very small
Pulse Shape	Shock front	Rounded	-
Positive Phase Duration, s	1.10	-	-

ROUND 3

Measurement Site	North Base (Mean of FC1 and FMT)	Iria	Roadside
Distance from Ground Zero, ft	24800	31400	48300
Peak Overpressure, p.s.i.	0.52	0.30	0.13
Pulse Shape	Shock front	Rounded	Rounded
Positive Phase Duration, s	1.6	-	-

TABLE 2

AIR BLAST DATA - STANDARDISED VALUES

Operation ANTLER Round No. 1 (1013 mb, 15°C, still air) Date 14/9/57 Time of Firing 1435 hours IK

Height of Burst; 105 ft

Conditions of Burst; Tower

Type of Terrain; Limestone strata overlain with fine red sand

Correction Factors (after Wind Correction)

Distance $\left(\frac{Po}{1013}\right)^{1/3}$; 0.996.

Pressure $\frac{1013}{Po}$; 1.012.

Site No.	Gauge Type	Ground Range, ft	Peak Overpressure, p.s.i.	Remarks
AG 205	Tubes	1272	5.0	Times of arrival for wind correction obtained from US Capabilities of Atomic Weapons 1955
AG 205	Tubes	1396	4.6	
AG 206	Tubes	1570	3.7	
AG 208	Tubes	1767	3.4	
AG 209	Tubes	2003	3.05	
AG 210	Tubes	2302	2.50	

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TABLE 3

AIR BLAST DATA - STANDARDISED VALUES

Operation ANTLER Round No. 2 (1013 mb, 15°C, still air) Date 25/9/57 Time of Firing 1000 hours IK

Height of Burst; 106 ft

Conditions of Burst; Tower

Type of Terrain; Limestone strata overlain with fine red sand

Correction Factors (after Wind Correction)

Distance $\left(\frac{Po}{1013}\right)^{1/3}$; 0.997. Time $\left(\frac{Po}{1013}\right)^{1/3}\left(\frac{273 + T}{288}\right)^{1/3}$; 0.995.

Pressure $\frac{1013}{Po}$; 1.009. Impulse (T × P); 1.004.

Site No.	Gauge Type	Ground Range, ft	Time of Arrival of Main Shock, s	Positive Duration, s	Peak Over-pressure, p.s.i.	Positive Impulse, p.s.i. s	Remarks
AG 411	FMT	1645	0.643	0.395	12.3	1.66	
AG 412	FMT	1844	0.777	0.433	10.5	1.66	
AG 401	FMT	2044	-	-	8.35	-	No time trace
AG 402	FMT	2203	1.042	0.492	7.28	1.45	
AG 403	FMT	2452	1.231	-	6.29	-	Recorder running erratically
AG 404	FMT	2662	1.397	0.518	5.25	1.21	
AG 405	FMT	2941	1.613	0.571	4.74	1.05	
AG 406	FMT	3210	1.828	0.586	4.05	0.91	
AG 407	FMT	3629	2.173	0.585	3.49	0.85	
AG 408	FMT	4077	2.548	0.645	2.71	0.78	
North Base	FMT	20936	-	-	0.28	-	Recorder hand switched

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TABLE 4

AIR BLAST DATA - STANDARDISED VALUES

Operation ANTLER Round No. 2 (1013 mb, 15°C, still air) Date 25/9/57 Time of Firing 1000 hours IK

Height of Burst; 106 ft

Conditions of Burst; Tower

Type of Terrain; Limestone strata overlain with fine red dust

Correction Factors (after Wind Correction)

Distance $\left(\frac{Po}{1013}\right)^{1/3}$; 0.997.

Pressure $\frac{1013}{Po}$; 1.009.

Site No.	Gauge Type	Ground Range, ft	Peak Overpressure, p.s.i.
AG 403	Tubes	2452	5.70
AG 404	Tubes	2662	5.00
AG 405	Tubes	2941	4.30
AG 406	Tubes	3210	3.50
AG 407	Tubes	3629	3.25
AG 408	Tubes	4077	2.40

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TABLE 5

AIR BLAST DATA - STANDARDISED VALUES

Operation ANTLER Round No. 3 (1013 mb, 15°C, still air) Date 9/10/57 Time of Firing 1615 hours IK

Height of Burst; 992 ft

Conditions of Burst; Triple balloon supported

Type of Terrain; Limestone strata overlain with fine red sand

Correction Factors (after Wind Correction)

Distance $\left(\frac{Po}{1013}\right)^{1/3}$; 0.992. Time $\left(\frac{Po}{1013}\right)^{1/3}\left(\frac{273 + T}{288}\right)^{1/2}$; 1.024.

Pressure $\frac{1013}{Po}$; 1.025. Impulse (T × P); 1.050.

Site No.	Gauge Type	Ground Range, ft	Time of Arrival, s		Positive Duration, s	Time to Second Shock, s	Peak Over-pressure, p.s.i.		Positive Impulse, S_2, p.s.i. s	Remarks
			Precursor	Main Shock			S_1	S_2		
AG 516	FMT	1353	0.435	-	0.545	0.904	30.1	5.88	6.09	
AG 517	FMT	1601	0.523	-	-	1.015	18.0	-	-	Gauge disconnected before end of positive phase
AG 512	FMT	1800	0.621	-	-	1.094	13.9	5.48	-	Gauge disconnected before end of positive phase
AG 513	FMT	2077	-	-	-	-	7.17	-	-	Fault occurred at time zero. No time trace
AG 514	FMT	2395	0.947	-	0.536*	1.481	8.50	0.221	2.42*	*Leaky gauge
AG 515	FMT	2693	1.157	-	0.743	1.676	9.99	0.219	3.12	
AG 501	FMT	2991	1.366	-	0.767	1.890	9.73	0.233	3.05	
AG 503	FMT	3835	-	2.013	0.709*	2.495	6.32	0.650	2.08*	*Leaky gauge
AG 504	FMT	4281	-	2.363	0.866	2.827	5.84	0.678	2.29	
AG 505	FMT	4827	-	2.785	0.943	3.240	4.73	0.548	2.11	
AG 506	FMT	5423	-	3.248	0.980	3.700	3.67	0.449	1.87	
AG 507	FMT	6068	-	3.782	1.06	4.212	3.23	0.369	1.65	
North Base	FMT	24798	-	-	-	-	0.54	-	-	Recorder hand switched
TR 517	FMT	1835	-	-	0.532	-	11.8	-	3.26	
TR 513	FMT	2265	-	-	0.701	-	12.0	-	3.75	

TABLE 6

AIR BLAST DATA - STANDARDISED VALUES

Operation ANTLER Round No. 3 (1013 mb 15°C, still air) Date 9/10/57 Time of Firing 1615 hours IK

Height of Burst; 992 ft

Conditions of Burst; Triple balloon supported

Correction Factors (after Wind Correction)

Distance $\left(\frac{Po}{1013}\right)^{1/3}$; 0.992.

Type of Terrain; Limestone strata overlain with fine red sand

Pressure $\frac{1013}{Po}$; 1.025.

Site No.	Gauge Type	Ground Range, ft	Peak Overpressure, p.s.i.
AG 502	Tubes	3386	3.7
AG 503	Tubes	3835	3.3
AG 504	Tubes	4281	4.8
AG 505	Tubes	4827	3.4
AG 506	Tubes	5423	2.8
AG 507	Tubes	6068	3.1
AG 508	Tubes	6858	2.6
AG 509	Tubes	7751	2.4

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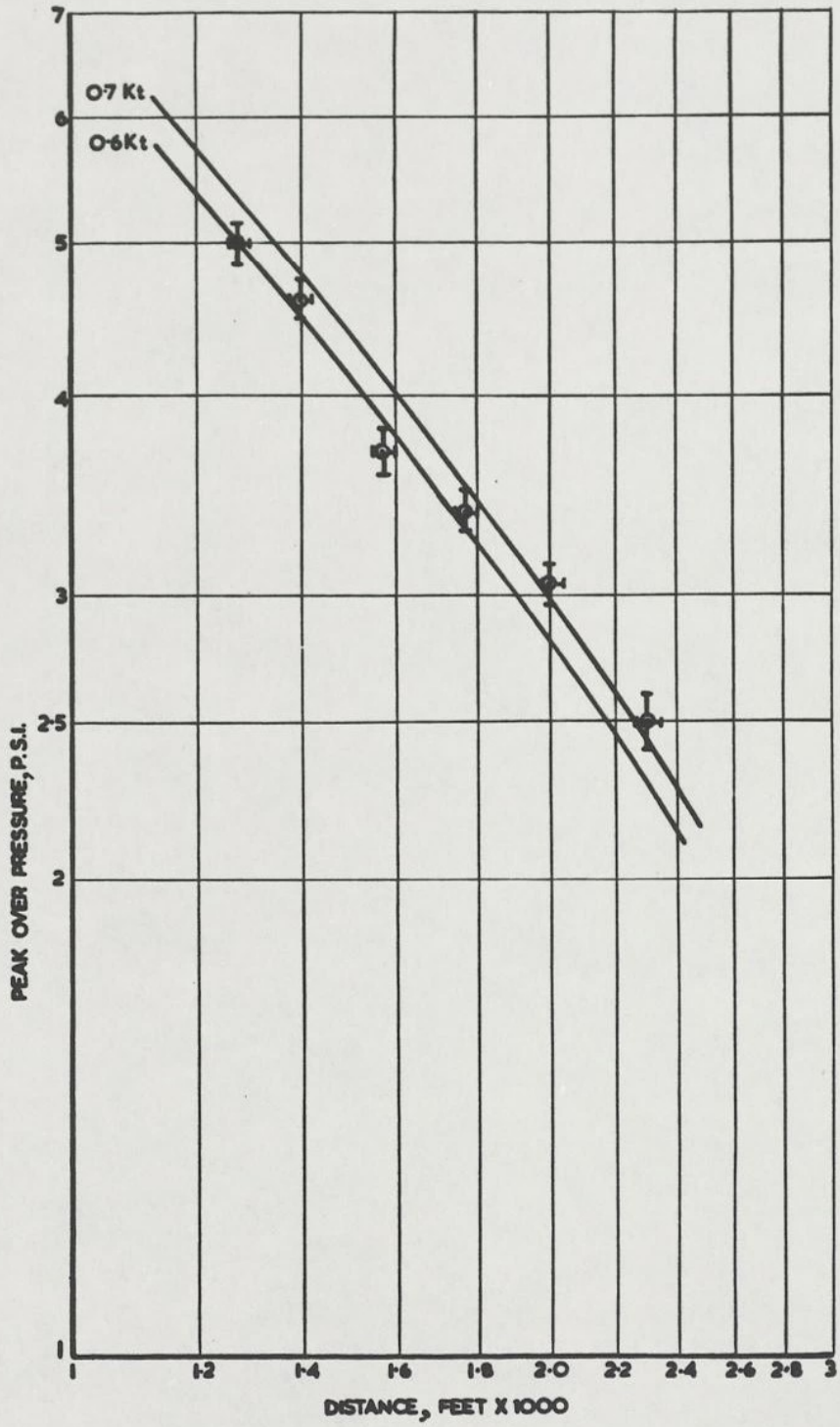

FIGURE 1. ROUND 1. PEAK OVER PRESSURE

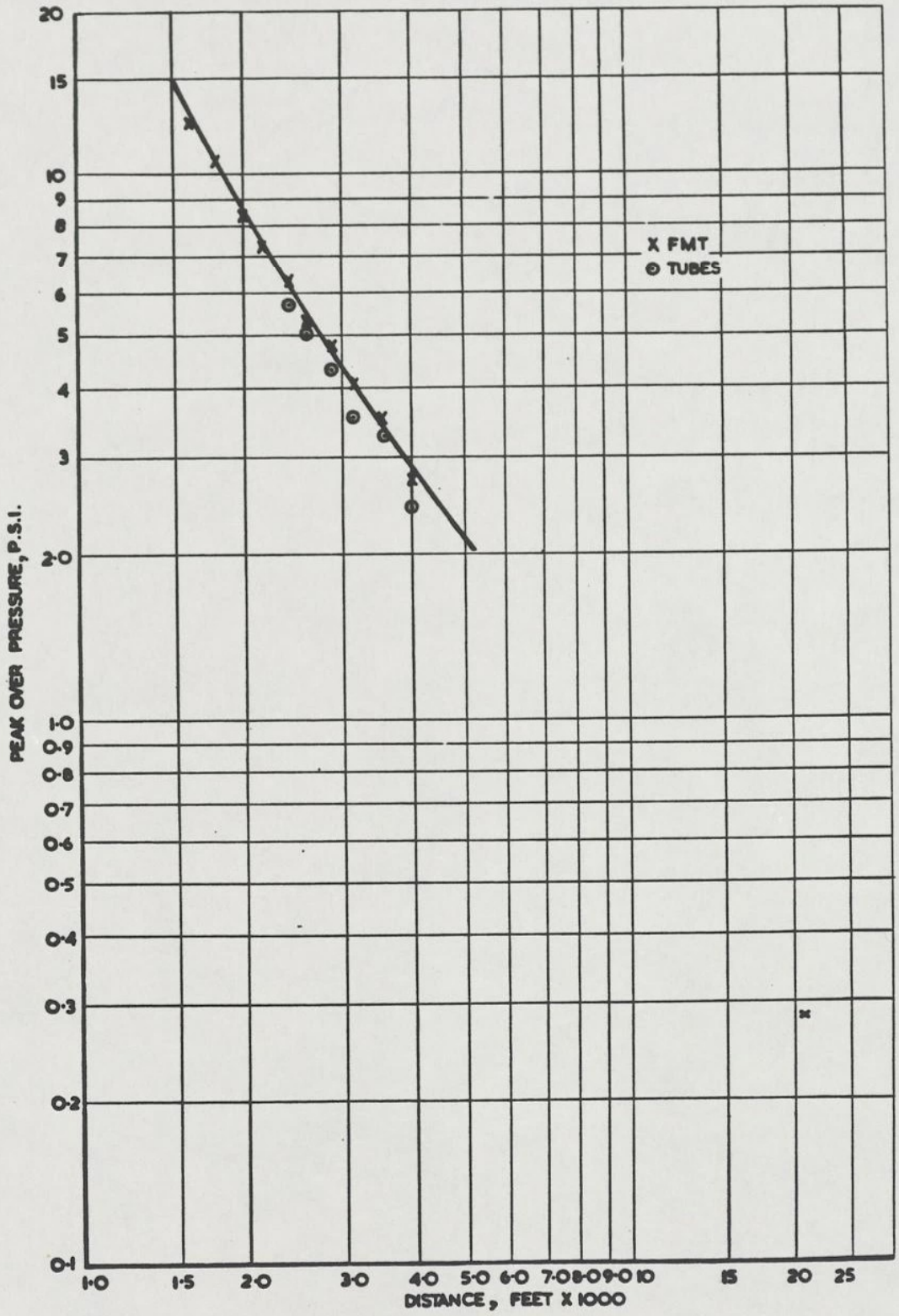

FIGURE 2. ROUND 2

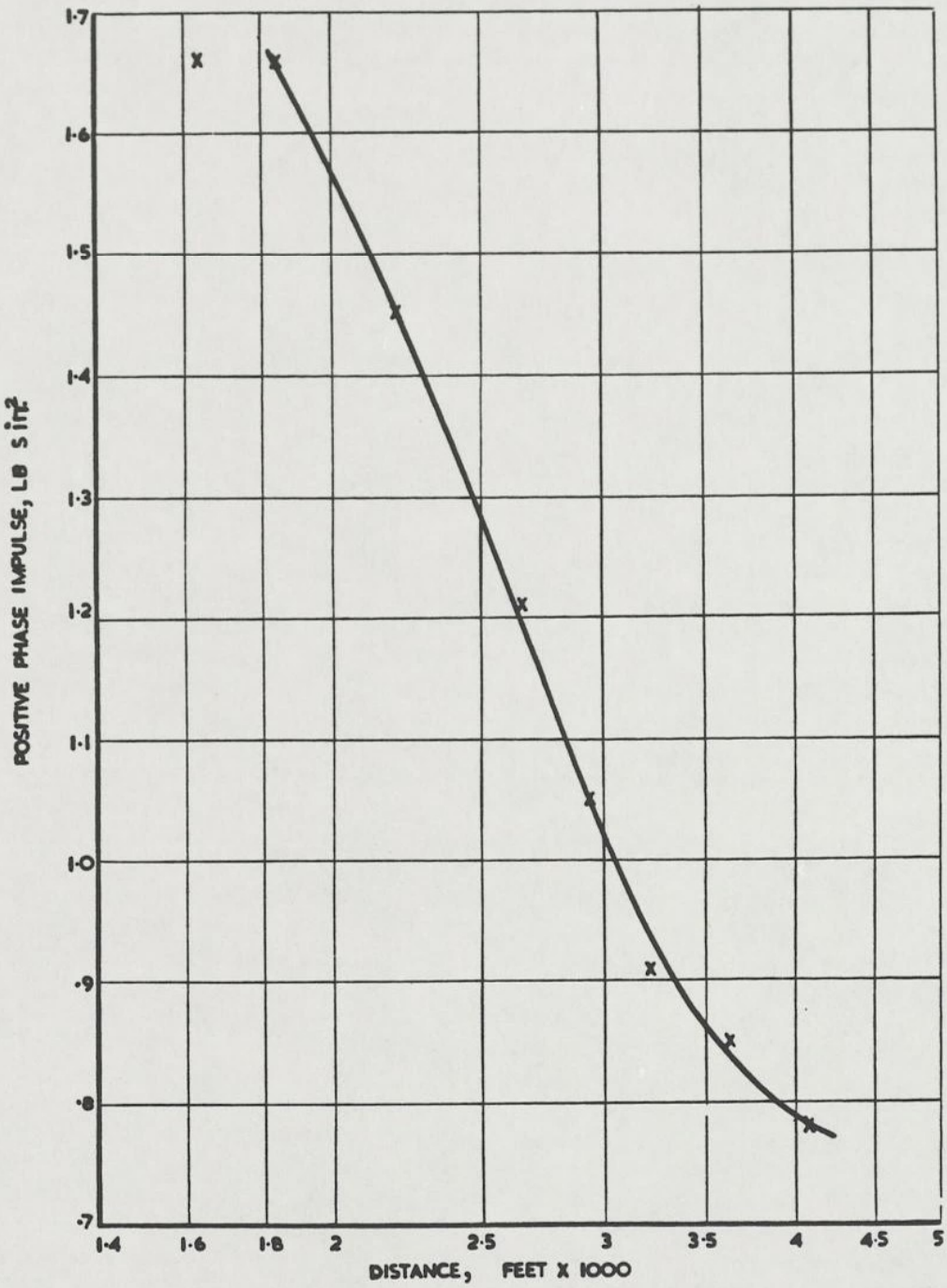

FIGURE 3. ROUND 2. POSITIVE PHASE IMPULSE

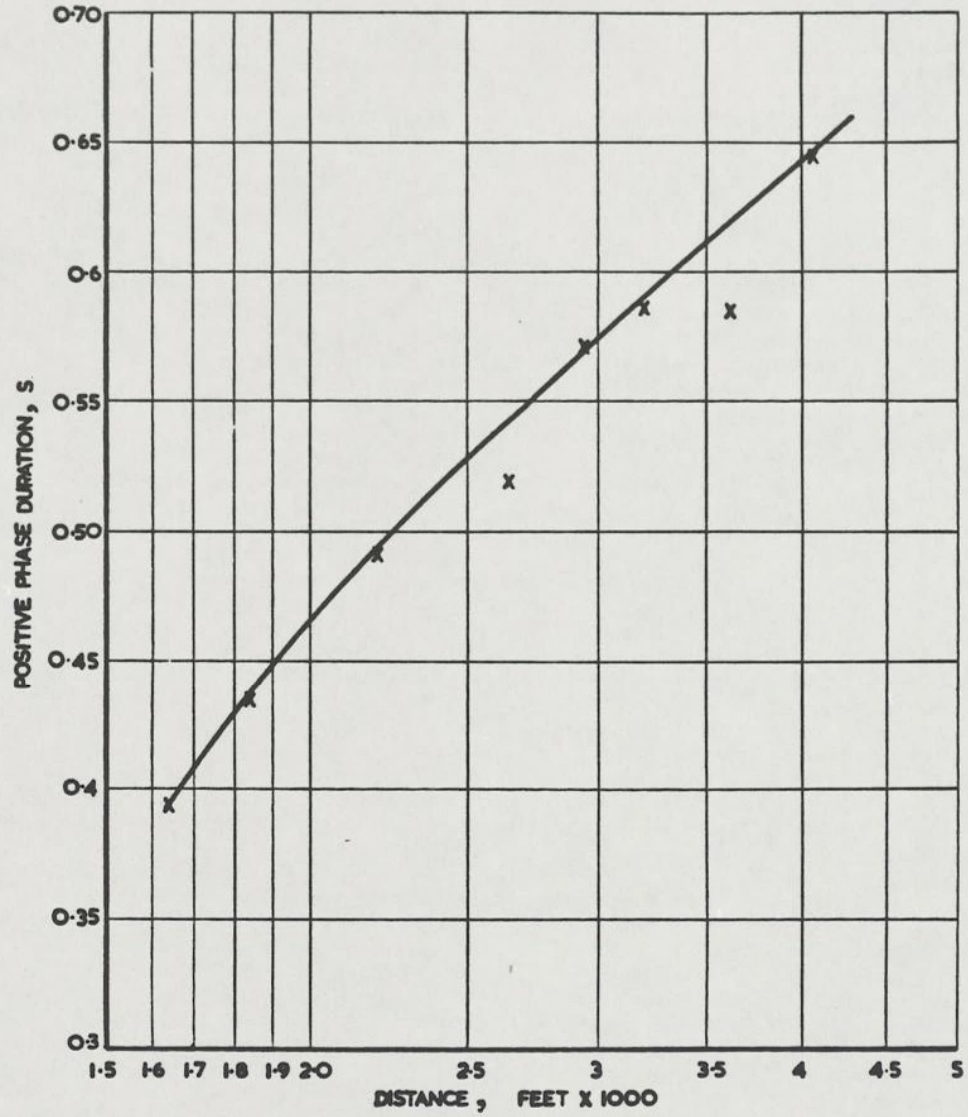

FIGURE 4. ROUND 2. POSITIVE PHASE DURATION

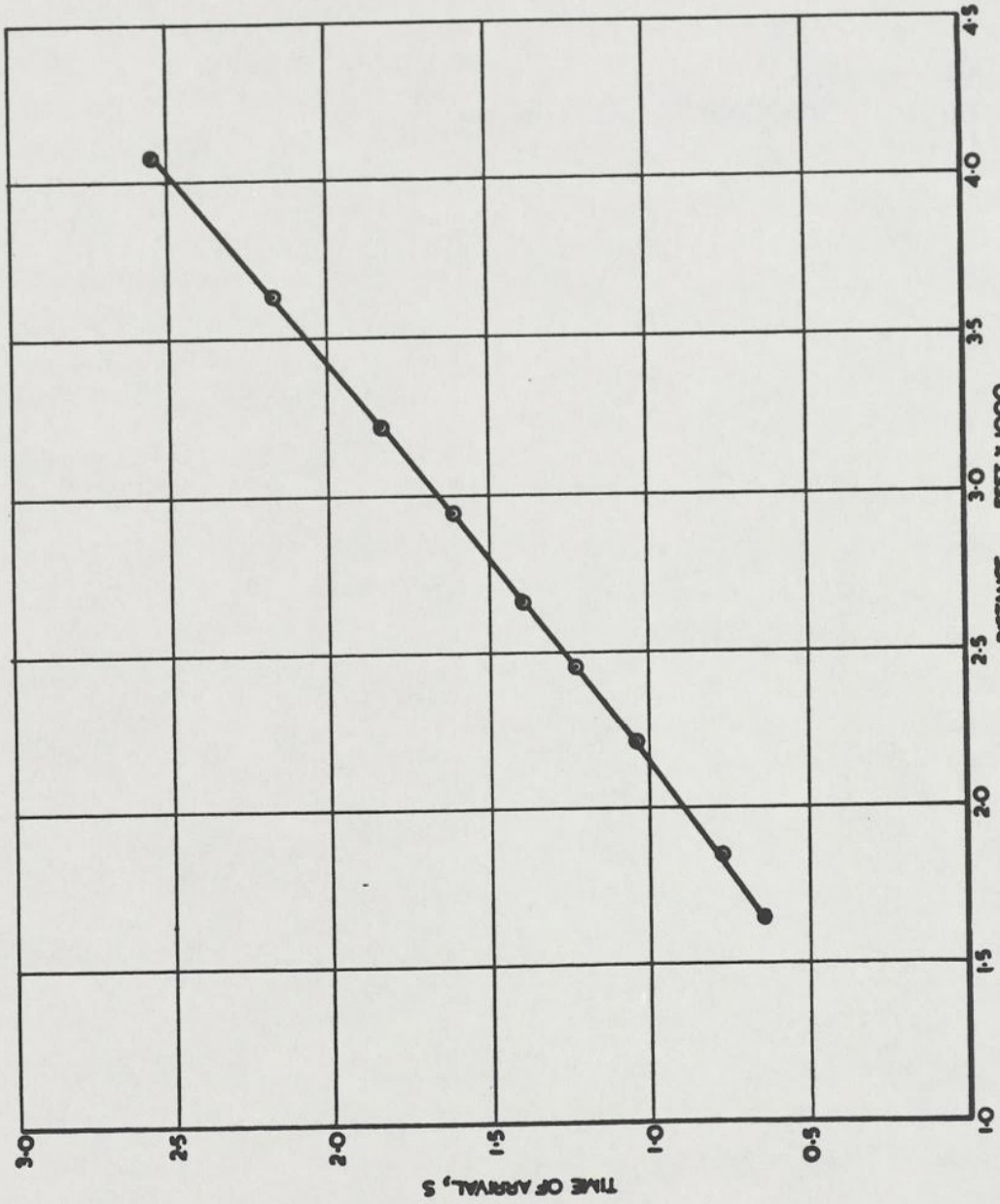

FIGURE 5. ROUND 2. TIME OF ARRIVAL CURVE

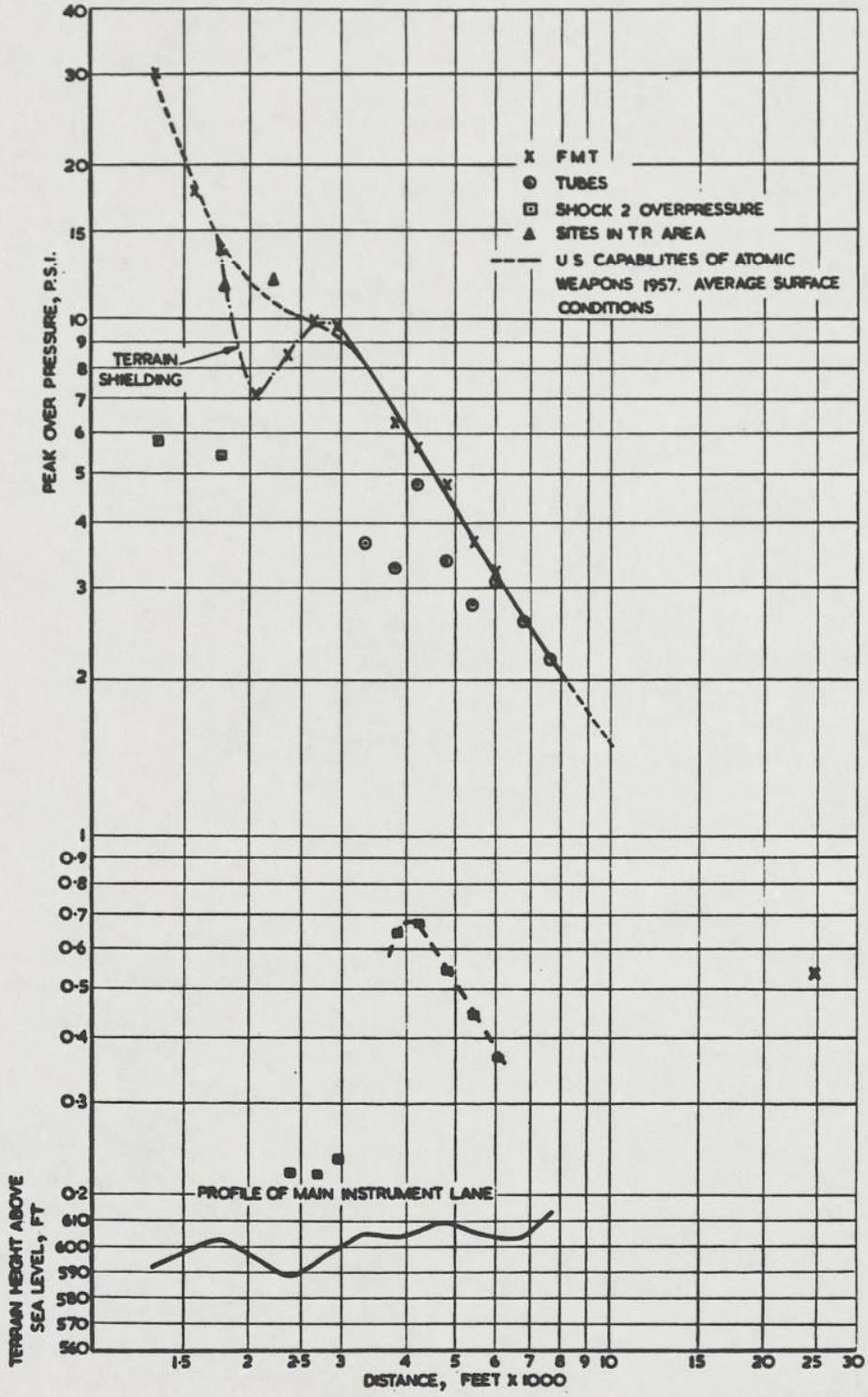

FIGURE 6. ROUND 3

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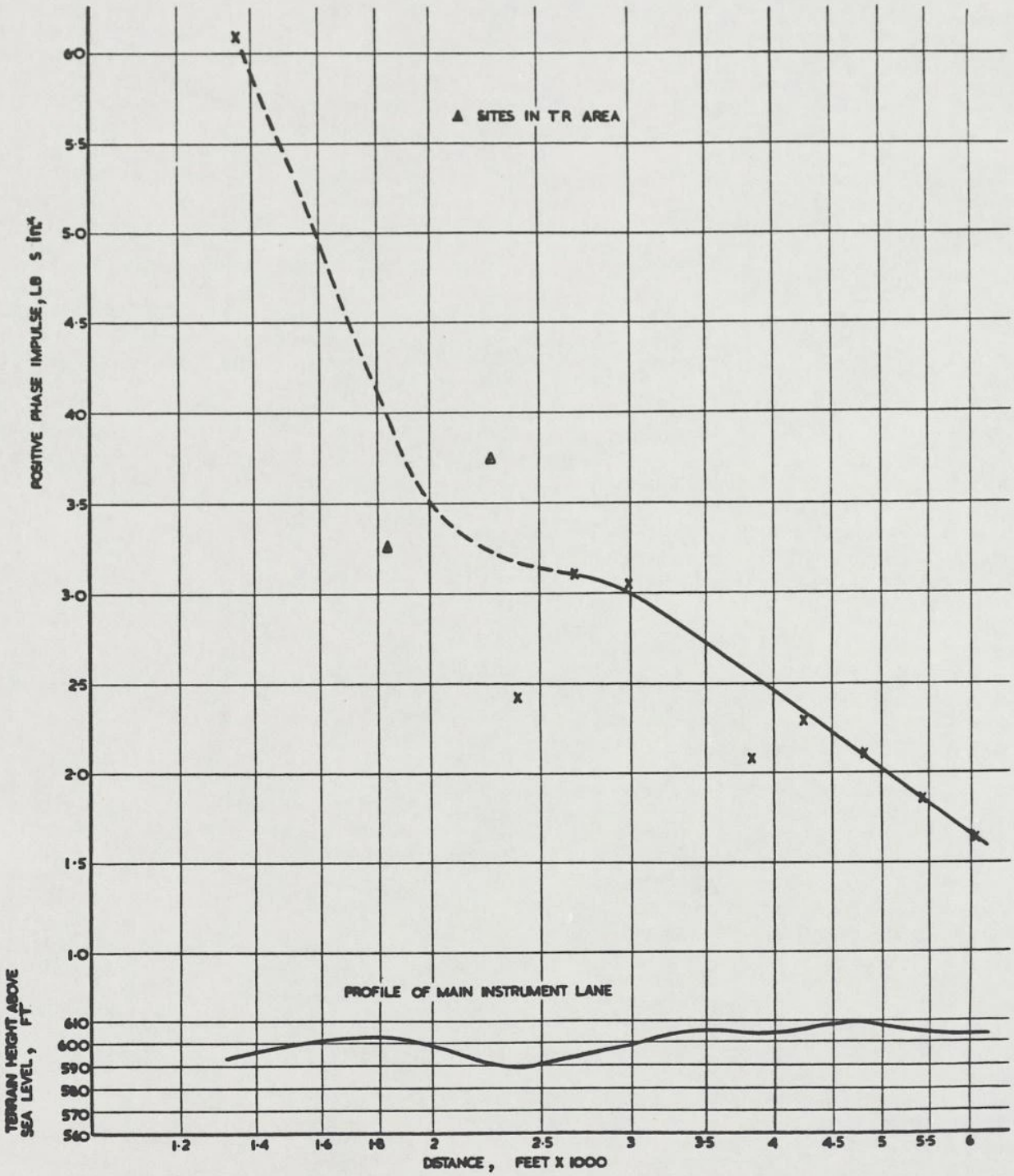

FIGURE 7. ROUND 3

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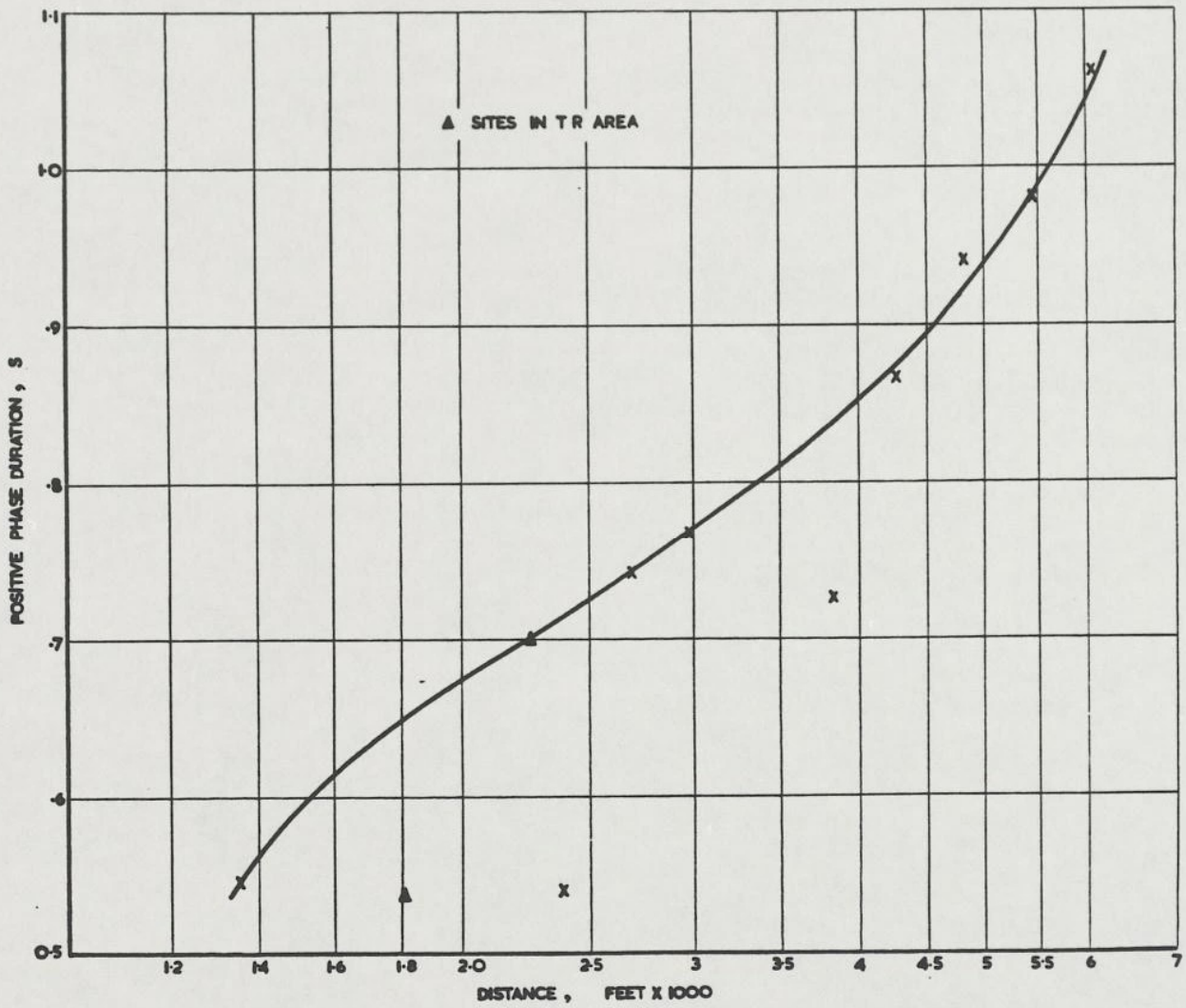

FIGURE 8. ROUND 3. POSITIVE PHASE DURATION

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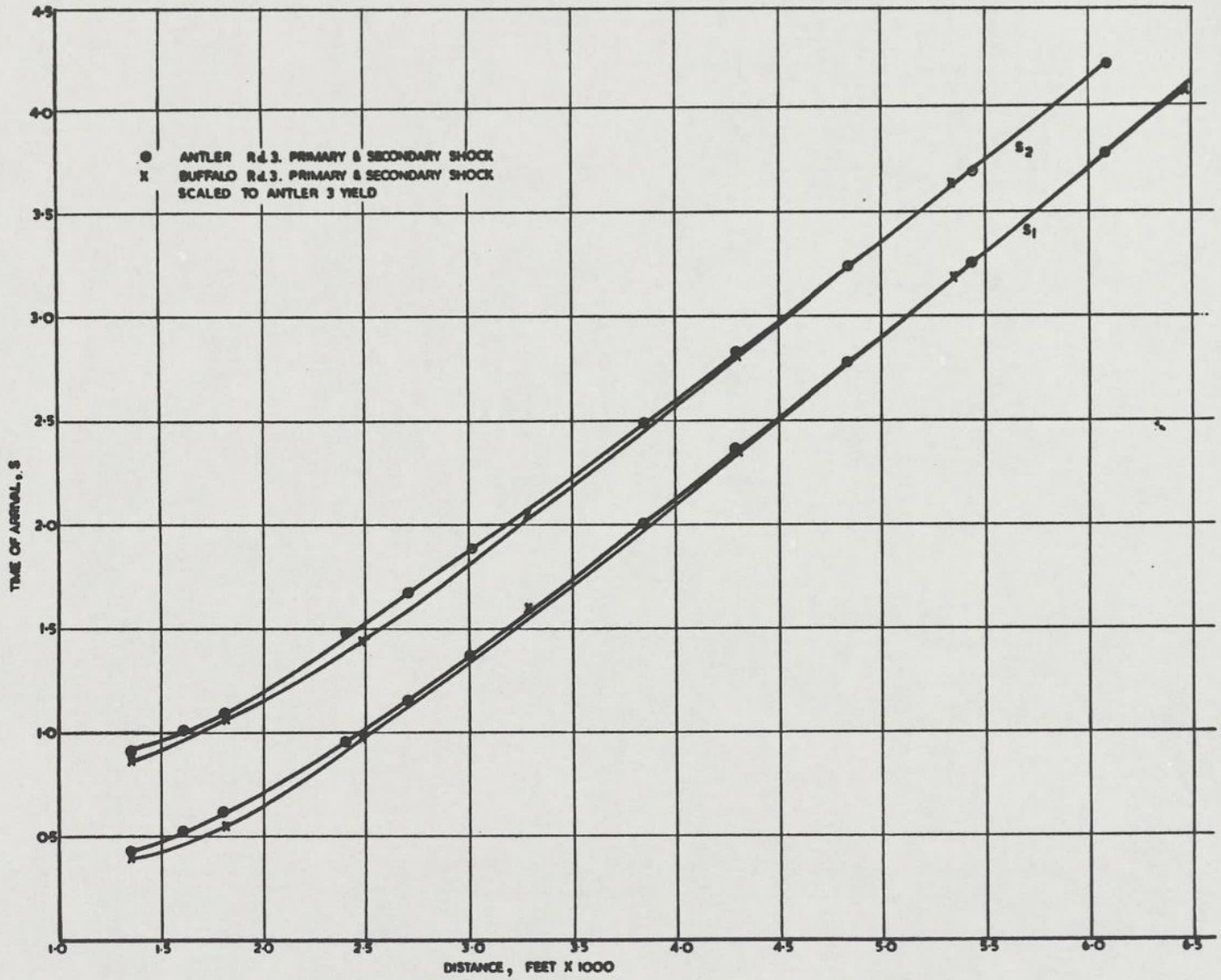

FIGURE 9. ROUND 3. TIME OF ARRIVAL CURVE

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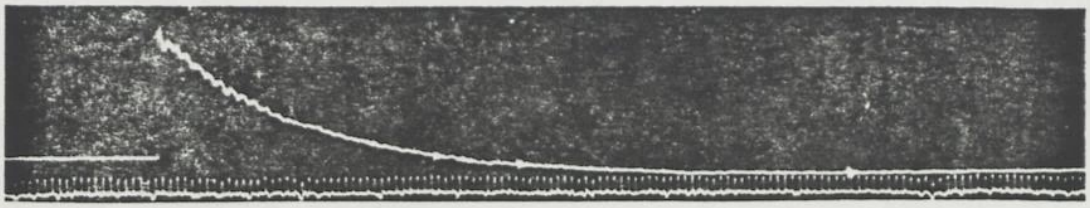

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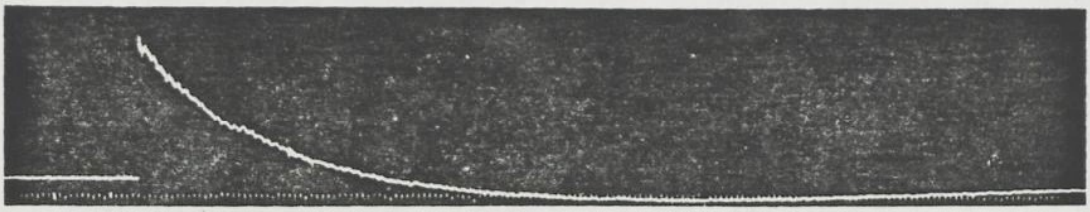

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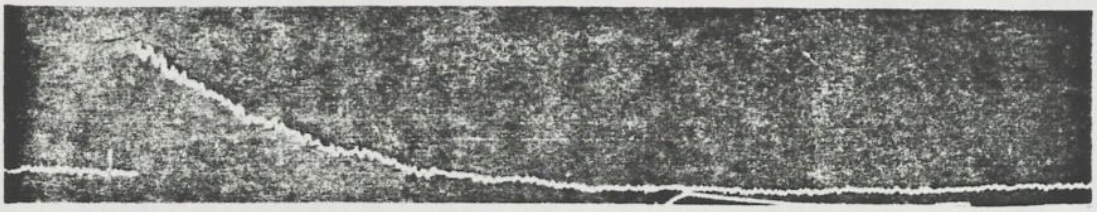
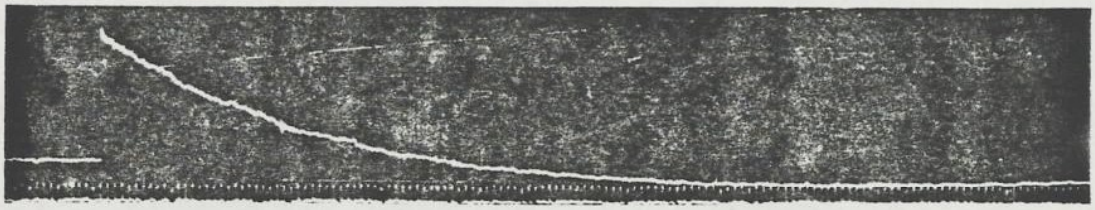
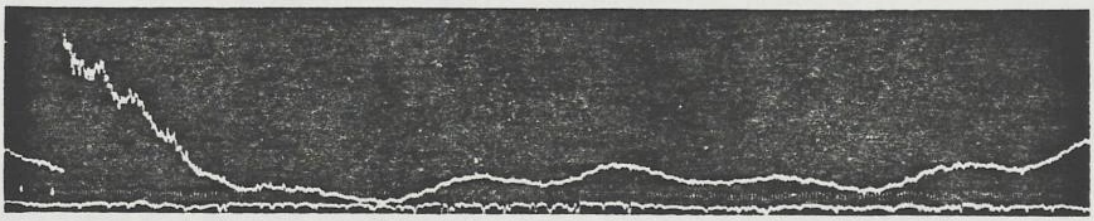


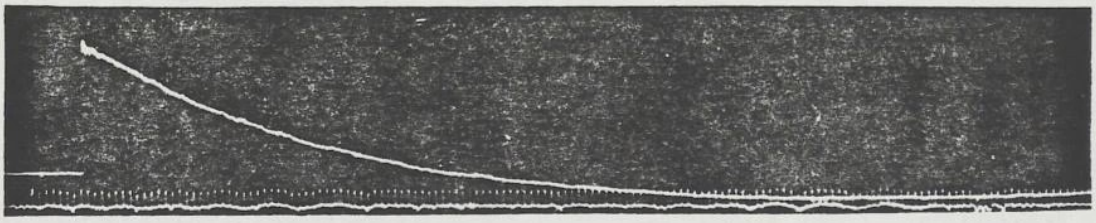
AG 401 2044 FT 8·35 P.S.I.



AG 402 2203 FT 7·28 P.S.I.



AG 403 2452FT 6·29 P.S.I.



AG 404 2662 FT 5·25 P.S.I.

FIGURE 10. ROUND 2

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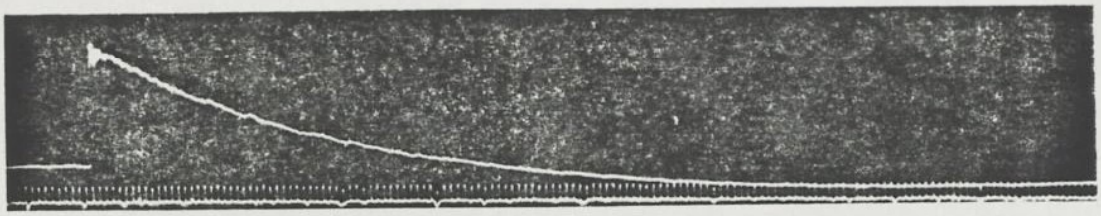
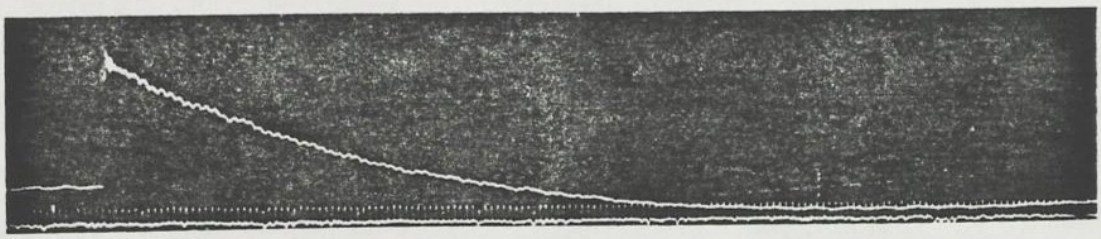
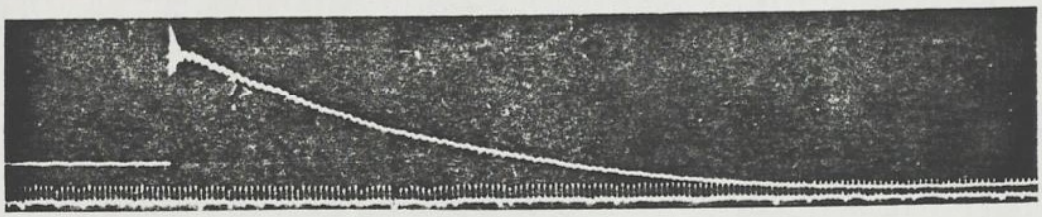
AG 405 2941 FT 4·74 P.S.I.



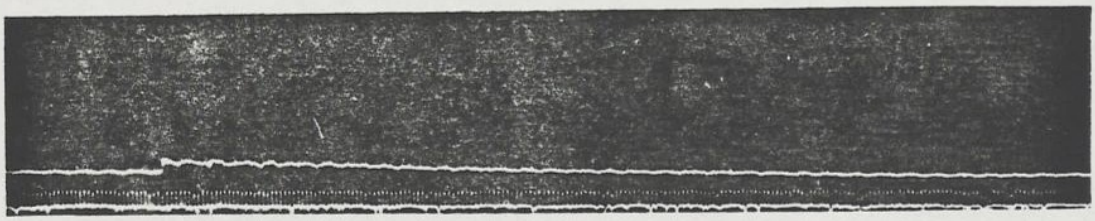
AG 406 3 210 FT 4·05 P.S.I.



AG 407 3 629 FT 3·49 P.S.I.



AG 408 4 077 FT 2·71 P.S.I.



NORTH BASE 20 936 FT 0·28 P.S.I.

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FIGURE 11. ROUND 2

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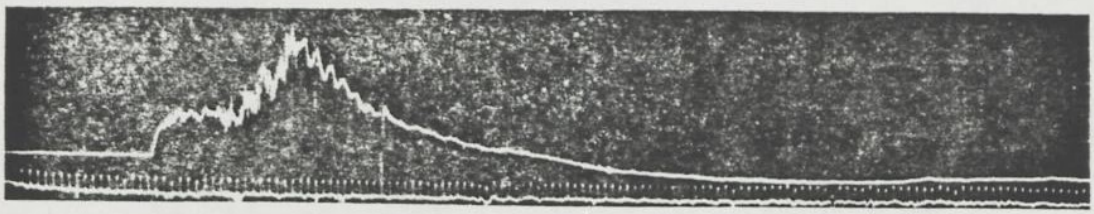
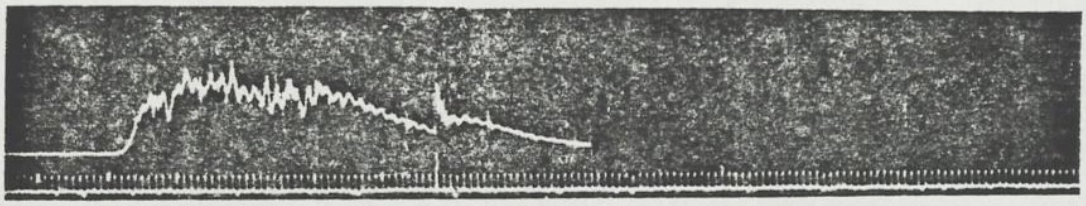
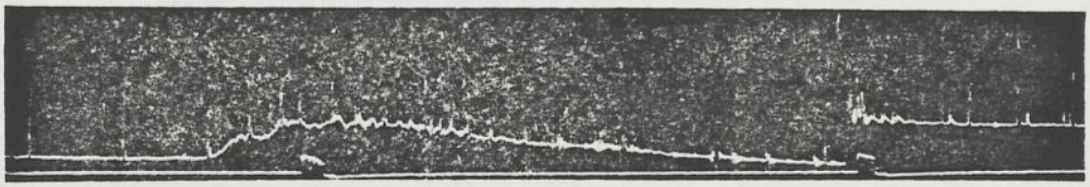


AG 516 1353 FT 30·1 P.S.I.

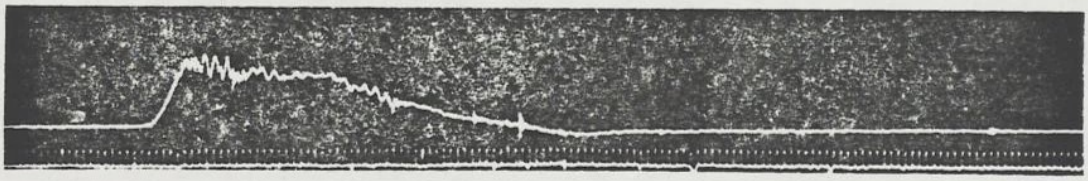
AG 517 1601 FT 18·0 P.S.I.



AG 512 1800 FT 13·9 P.S.I.



AG 513 2077 FT 7·17 P.S.I.



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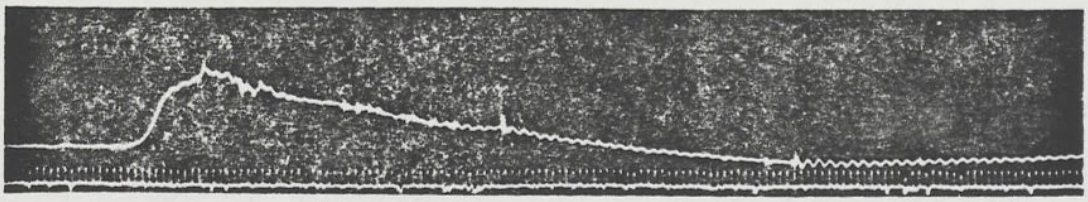

AG 515 2693 FT 9·99 P.S.I.

FIGURE 12 ROUND 3

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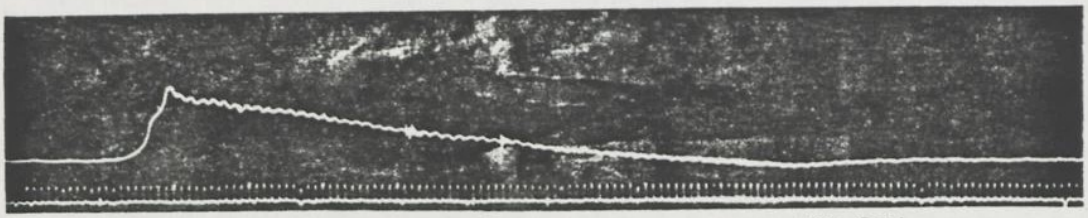

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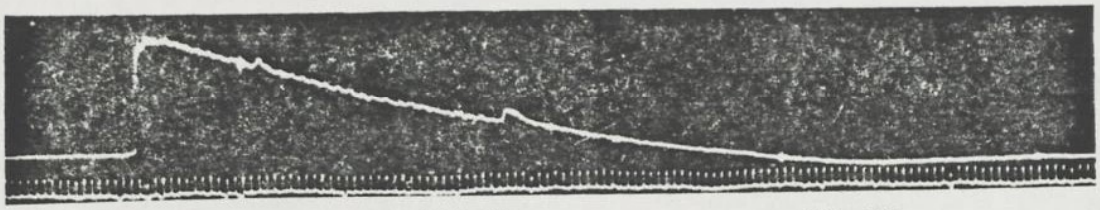
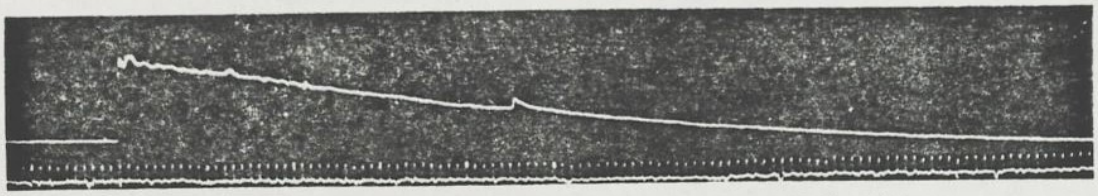
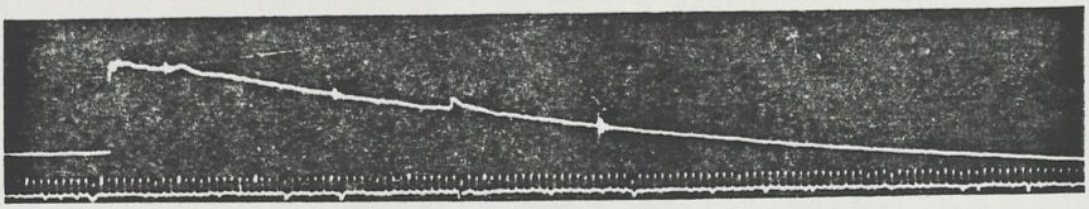


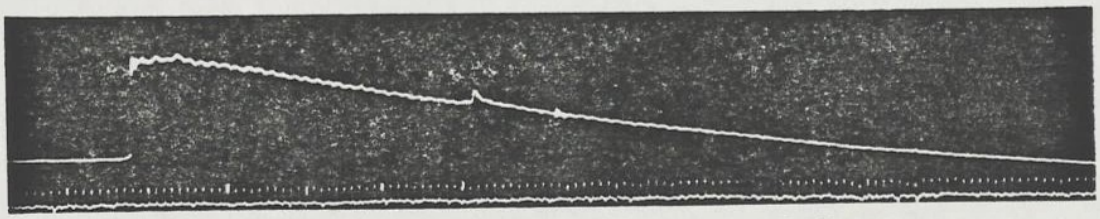
AG 503 3835 FT 6·32 P.S.I.



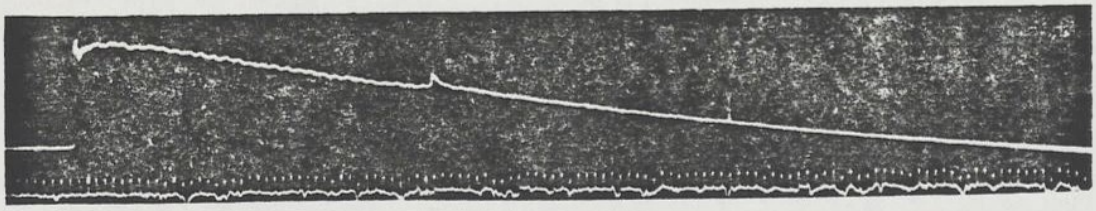
AG 504 4 281 FT 5·84 P.S.I.



AG 505 4 827 FT 4·73 P.S.I.



AG 506 5 423 FT 3·67 P.S.I.



AG 507 6 068 FT 3·23 P.S.I.

FIGURE 13. ROUND 3

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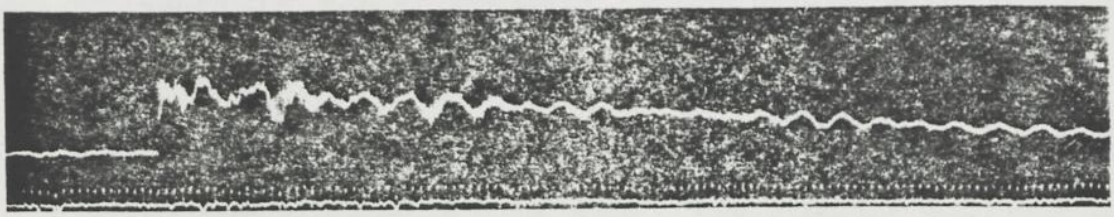
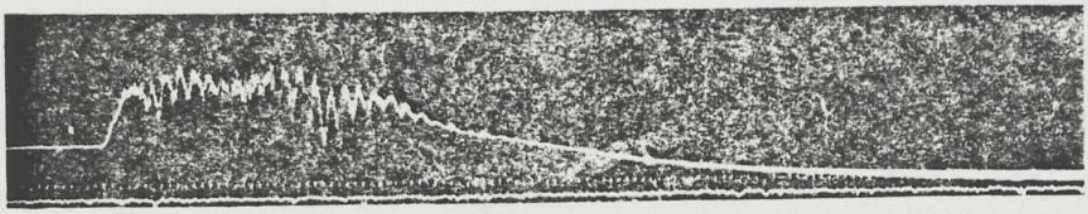
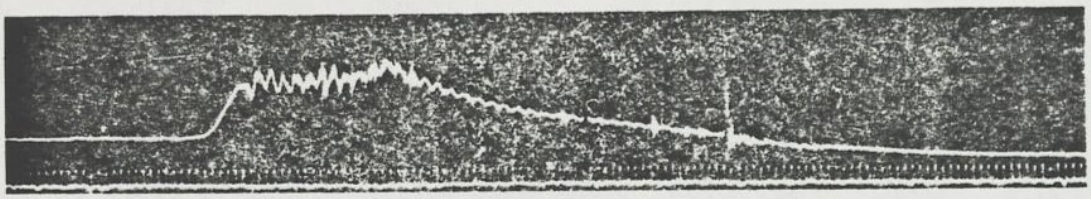


NORTH BASE 24 798 FT 0·54 P.S.I.



TR 517 1 835 FT 11·8 P.S.I.



TR 513 22 65 FT 12·0 P.S.I.

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FIGURE 14. ROUND 3

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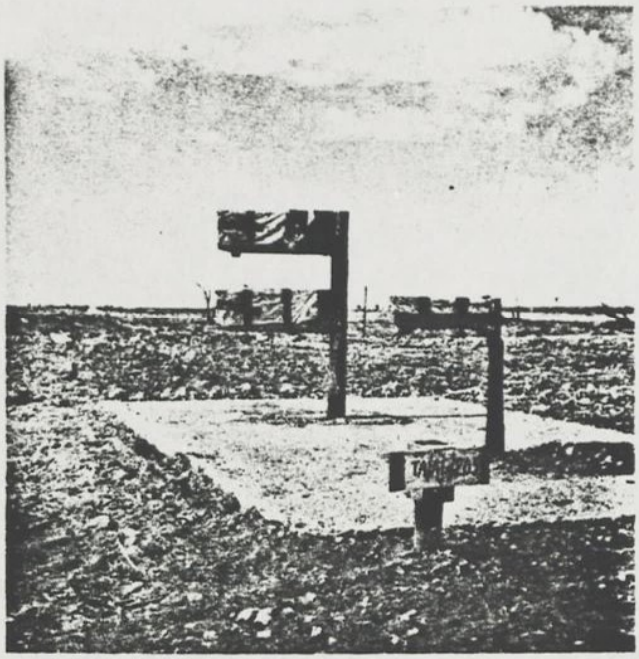

FIGURE 15. SITE AG 205 ROUND 1. TYPICAL INSTALATION

FIGURE 16. SITE AG 513 ROUND 3. 2077 FT FROM GZ LOOKING FORWARD TO THE RIDGE AT 1700 FT

Initial Distribution

Internal

No.	1	DAWRE, Mr. E. F. Newley
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	11	Mr. P. J. Atkins, SFP
	12	Mr. P. W. G. Burgess, SFP
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	15	Mr. W. E. Jones, CPA

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	20-21	Under Secretary of State (OSR2), War Department and for Commandant, Royal Military College of Science, Shrivenham
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DEFE 16/444

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Reference A8/633/58/CAA 0141

11/4/85
MINISTRY OF DEFENCE
SC (NUC) 2
LONDON S.W.1.

6056 Permanent Proving Ground Trials
0171 IC

Admiral P.W.Brooking

U/c wth Def Nuc Tech info 23/1/85

Co 60 pellets found at Maralinga

Downgraded to. UNCLASSIFIED

DEFE 16/443

Halliday rang me this morning to say that Myers has been enquiring about the Co60 pellets found at Maralinga by Turner. I have tried, without success, to ring Myers to find his source of information and the reason why he is pursuing the matter. The facts are as follows:-

Co60 was used at Antler as a detector. With some difficulty I obtained permission from the Director to inform Titterton (as Chairman of the Safety Committee) that we intended to use such an indicator. Titterton was entirely sympathetic, raised no difficulties, realised that we were not adding any real hazard, and agreed that the information should go no further on the Australian side. Recently Turner, the Australian who is responsible for Health Physics at Maralinga in the inter-trial period, claims to have found Co60 in some pellets which he has collected and which we have arranged should be sent back to U.K. As soon as I heard of this I wrote to Titterton stating what the position was and suggesting that it would be as well if information on this subject were not extended any further in Australia. I have not as yet had any reply from him.

I shall not have an opportunity to get in contact with Myers today. Tomorrow evening I leave for Risley and expect to be in again on Friday. You may think it worthwhile to get in touch with Myers. The fact that he is asking questions on the subject suggests that the information has already received a wider circulation than I thought it would.

/Since

EGIMITE
& C M Ltd.
52-2165
ode 18-76

12th August, 1958

~~SECRET~~

SECRET U.K. EYES ONLY Reference A0/633/58/CAA

Since dictating the above I have had a call from Frankie Lloyd who raised the matter of Co60 amongst other things. It appears that Turner has reported to Dick Durance in addition to reporting here. In doing so I think Turner has misconstrued his terms of reference which were to report in the first instance to A.W.R.E. The correspondence will be sent down here by Frankie. I hope that I shall shortly have a reply from Titterton but at present I do not know how to get in touch with him. I have asked Mrs. Prosser to find from Australia House where Titterton can be contacted. If it is necessary to correspond with the Australian Department of Supply or the Range Commander, I should much prefer to do so in terms agreed with Titterton, rather than to write indepdently.

C.A.A.

C. A. Adams
C.T.

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T 62/57

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UNITED KINGDOM ATOMIC ENERGY AUTHORITY

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101

BB005

REPORT No. T 62/57

THE INFORMATION CONTAINED IN THIS DOCUMENT IS CLASSIFIED CONFIDENTIAL AND NOT AS INDICATED WITHIN RMCS Date 29.5.86

OPERATION BUFFALO

Air and Ground Shock Measurements Group

Group Leader - N. S. Thumpston

CONFIDENTIAL

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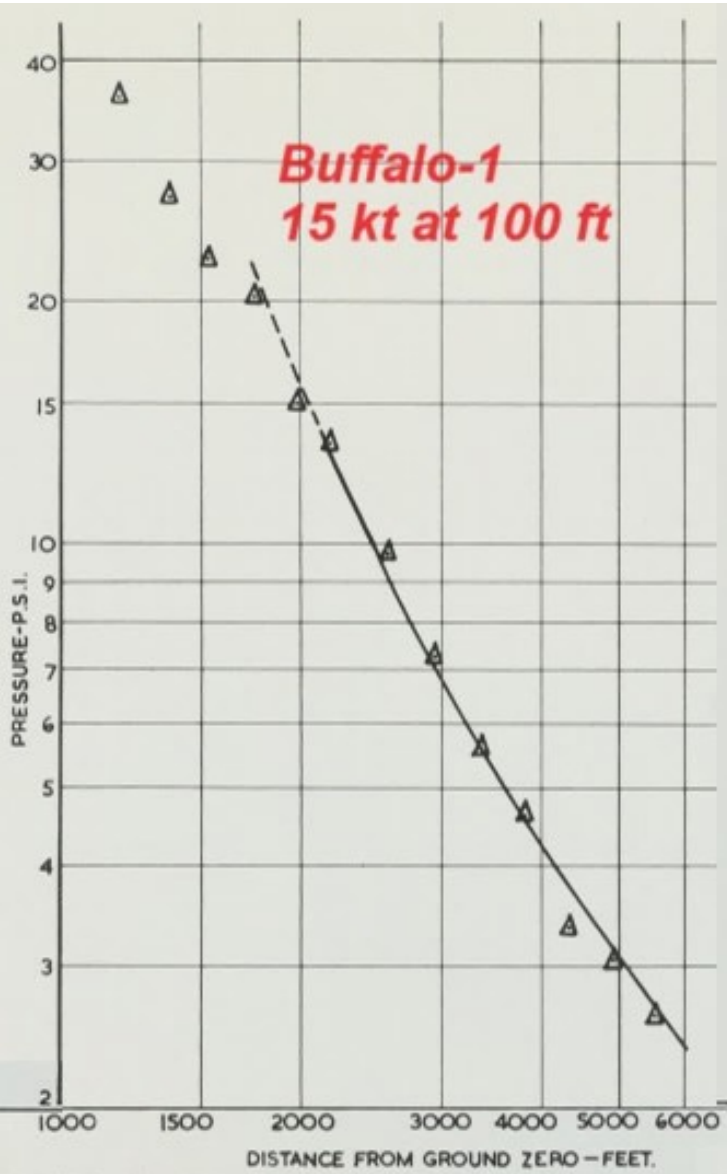
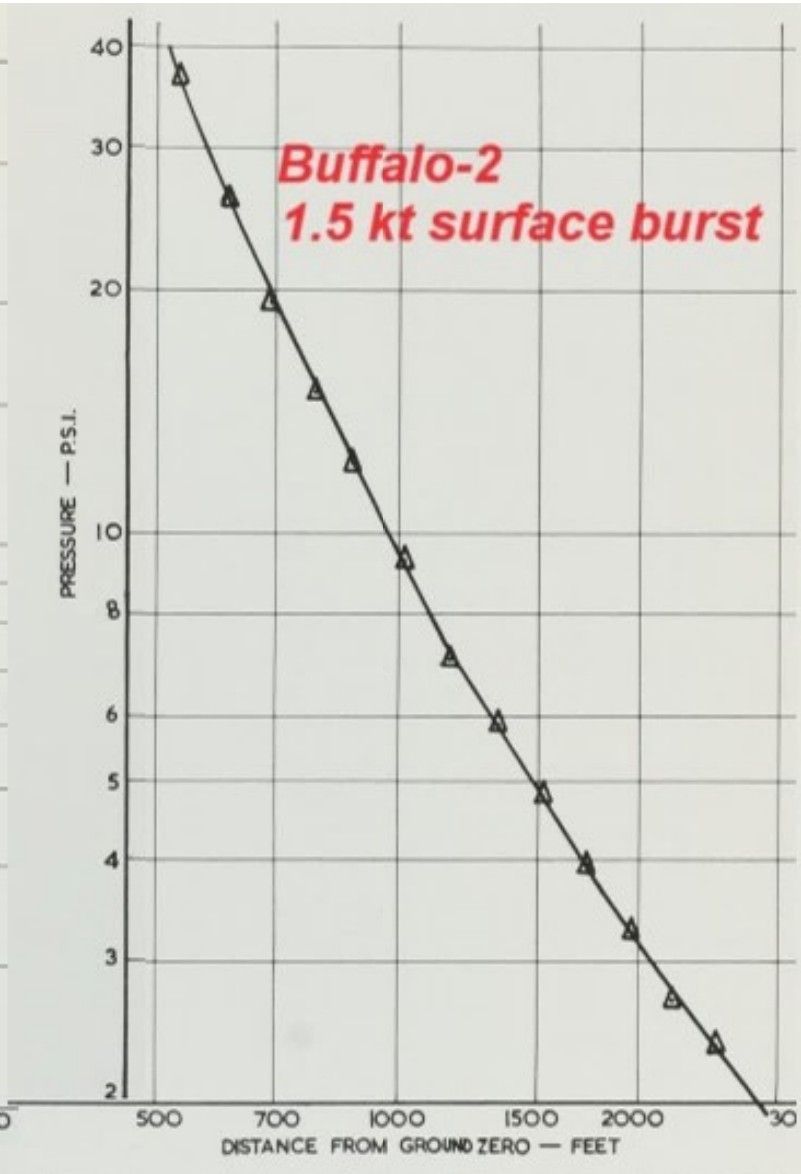
~~GUARD~~

A.W.R.E.,
Aldermaston, Berks.

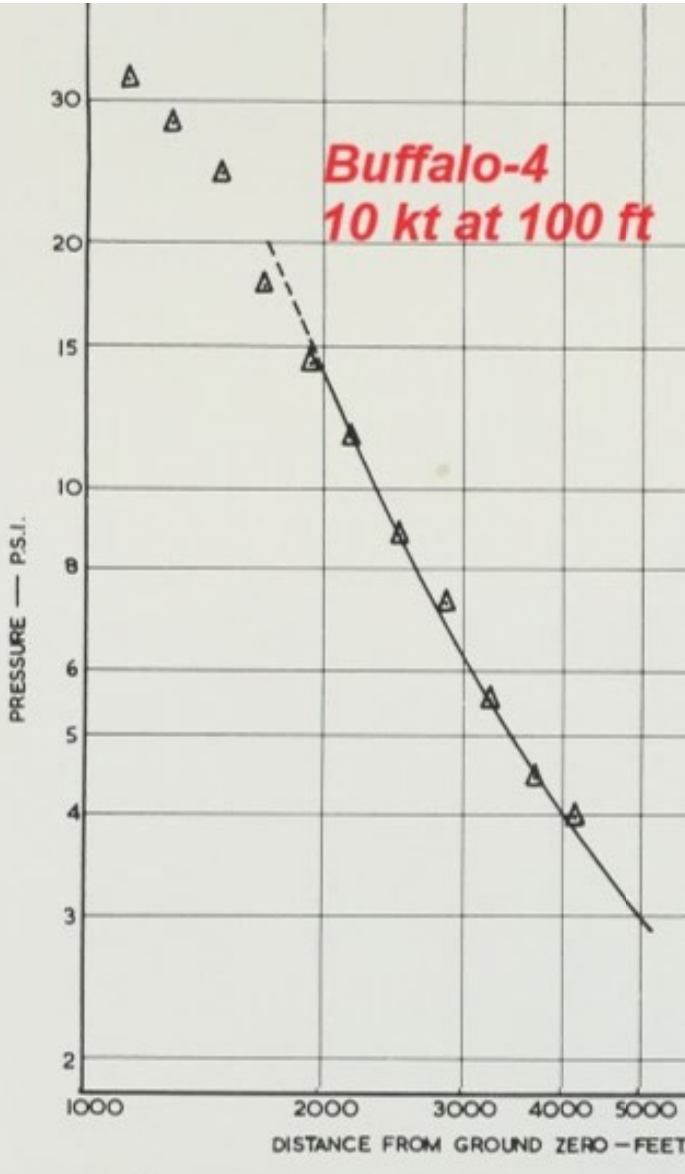
November, 1957



ROUND.1. – PRESSURE/DISTANCE CURVE. FMT



ROUND 2. – PRESSURE/DISTANCE CURVE FMT RESULT



ROUND 4.-PRESSURE/DISTANCE CURVE FMT

15 kt at 100 ft height of burst

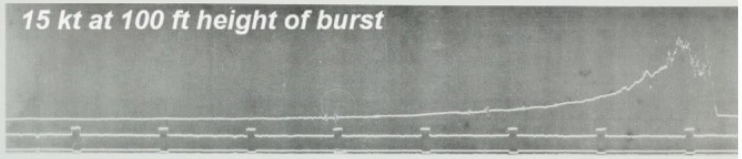


FIG.5. Buffalo-1 precursor AG 104 1170 FT. 36 P.S.I.

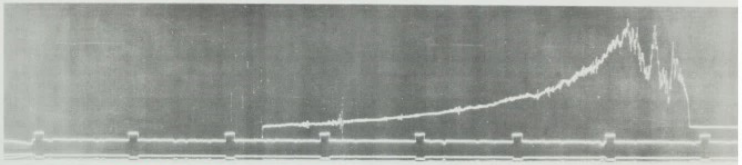


FIG.7. Buffalo-1 precursor AG 108 1520 FT. 22·7 P.S.I.

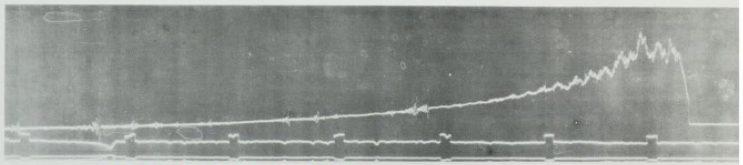


FIG.8. Buffalo-1 precursor AG 109 1730 FT. 20·4 P.S.I.

FIG.9. Buffalo-1 near ideal AG 111 1960 FT. 15 P.S.I.

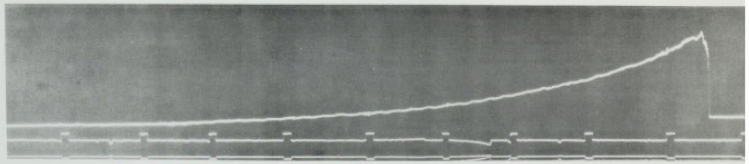


FIG.10. Buffalo-1 near ideal AG 112 2140 FT. 13·5 P.S.I.

Buffalo-1 precursor waveform development and fading
Ambient air: 22C, 998mb, 18% humidity

3 kt at 490 ft height of burst

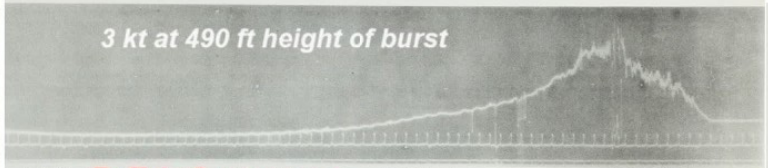


FIG.21. Buffalo-3 precursor AG 405/1 740 FT. 24·7 P.S.I.

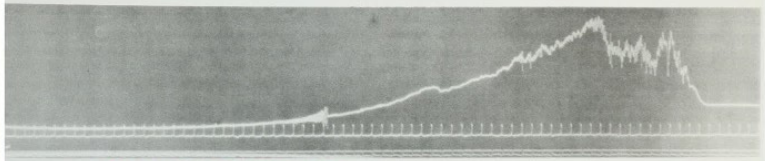


FIG.22. Buffalo-3 precursor AG 407 990 FT. 16·4 P.S.I.

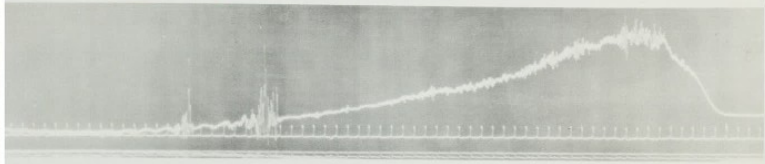


FIG.23. Buffalo-3 precursor AG 408 1320 FT. 9·9 P.S.I.

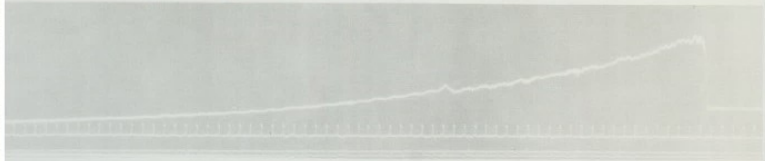


FIG.24. Buffalo-3 near ideal AG 411 1750 FT. 8·9 P.S.I.

(Buffalo-3 ambient air: 24.1C, 998mb, 35% humidity)

F.M.T. blast pressure gage with magnetic tape system

10 kt at 100 ft height of burst

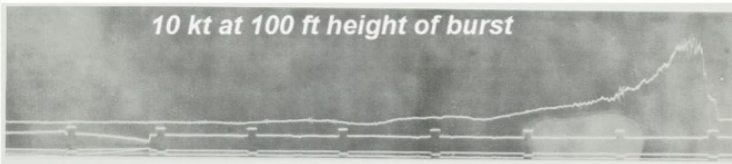


FIG.11. Buffalo-4 precursor AG 304 1140 FT. 32 P.S.I.

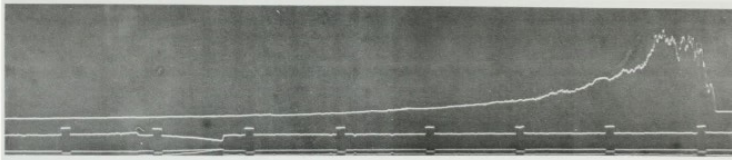


FIG.12. Buffalo-4 precursor AG 306 1290 FT. 28 P.S.I.

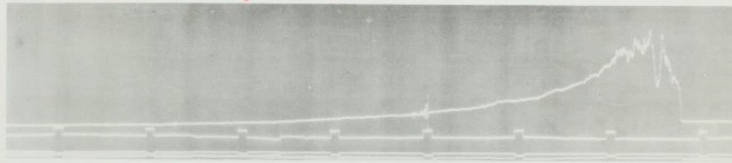


FIG.13. Buffalo-4 precursor AG 308 1480 FT. 24·4 P.S.I.

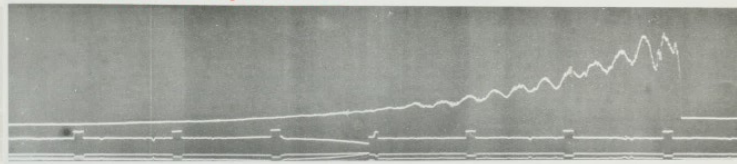


FIG.14. Buffalo-4 precursor AG 310 1680 FT. 17·8 P.S.I.

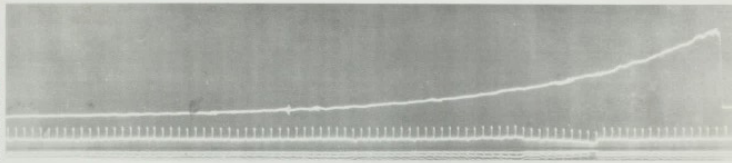


FIG.15. Buffalo-4 near ideal AG 311 1920 FT. 14·2 P.S.I.

Buffalo-4 ambient air: 13.1C, 994mb, 84% humidity

1.5 kt Buffalo-2: Maralinga surface burst

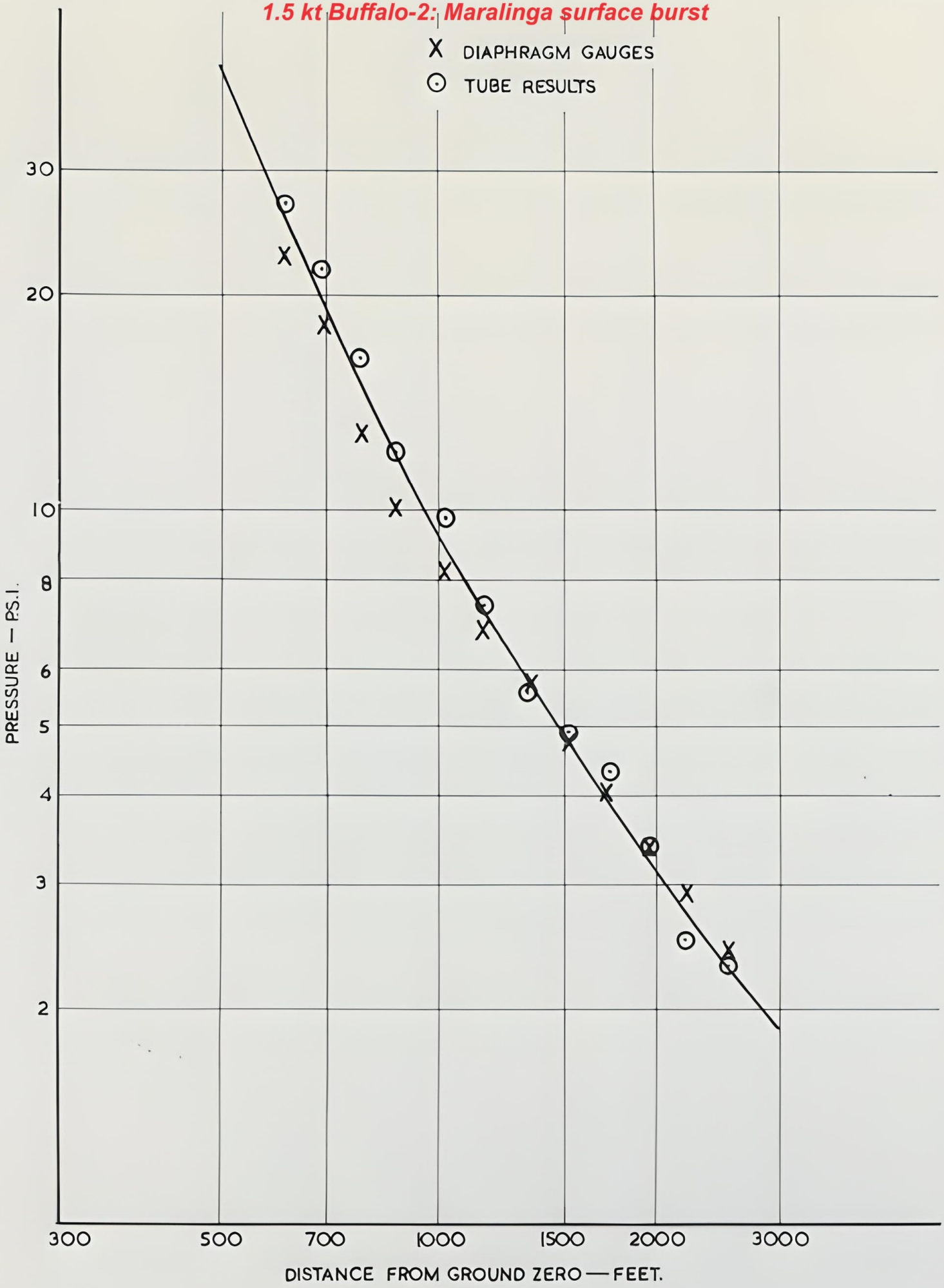


FIG. 30. ROUND 2. — PRESSURE / DISTANCE CURVE. DIAPHRAGM & TUBE RESULTS

AWRE 1956 Height of burst curves used for yield

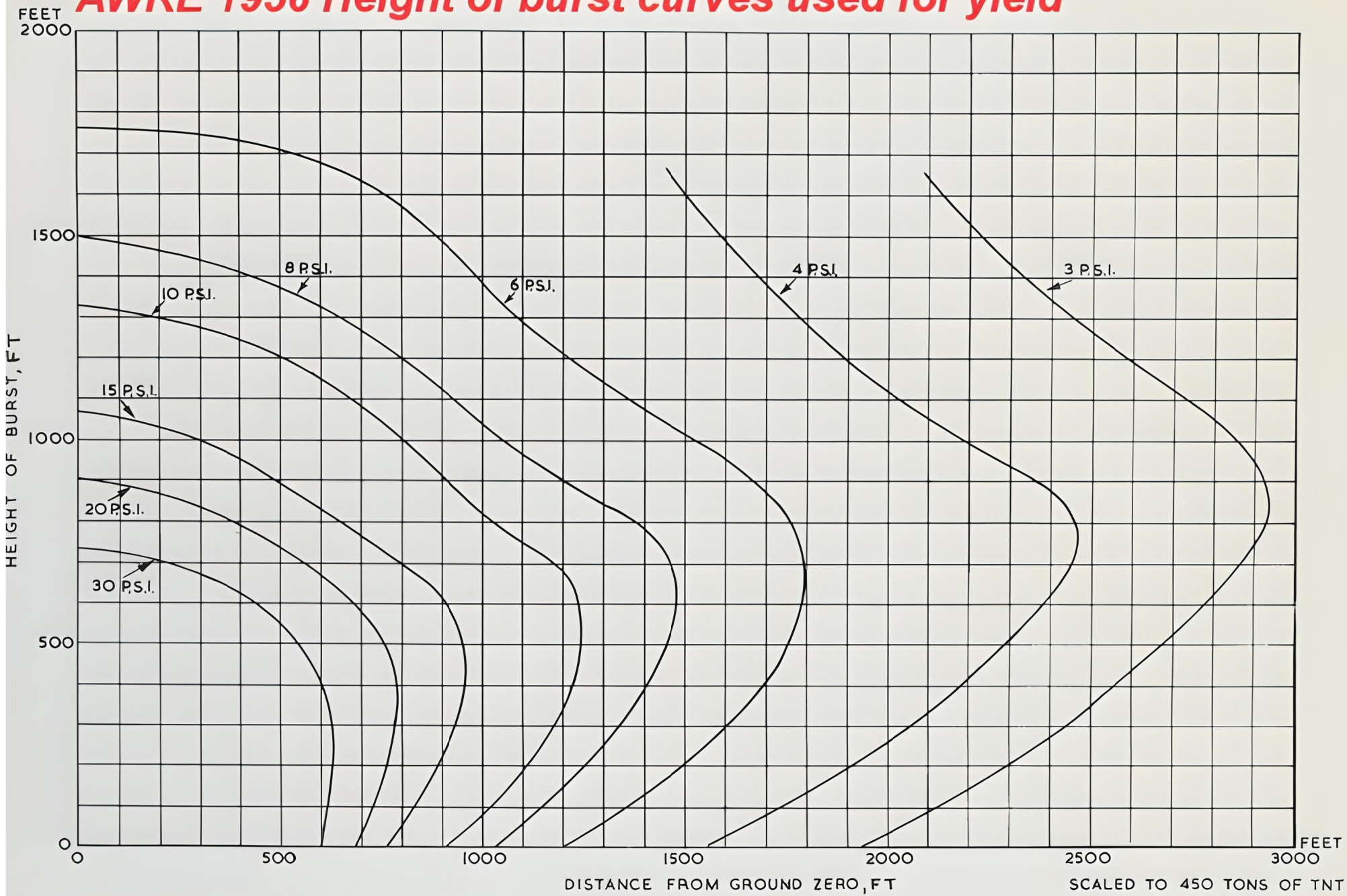


FIGURE 41. HEIGHT OF BURST: PRESSURE / DISTANCE DATA FOR 450 TONS OF T.N.T.

AWRE T 62/57 used this 0.45 kt of TNT overpressure height of burst (0.45 kt was supposed to be the blast yield of 1 kt total yield nuclear bomb) to estimate yields of 17, 1, 2.5 and 15 kt for Buffalo shots (or "rounds") 1, 2, 3 and 4.

There are issues with this, first blast yield is not always 45%, and TNT tests in the UK over concrete don't compare well to Maralinga.

Initial Distribution

Internal

No. 1	DAWRE, Sir William Penney
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3	CR, Mr. C. A. Adams
4	CWD, Mr. E. F. Newley
5	Declassification Officer, Dr. A. H. Davis
6	SSFD, Mr. E. F. Mott
7	SSPD, Dr. J. Corner
8	SSTD, Mr. R. Pilgrim
9	DSSF, Mr. C. L. Farror
10	SPT, Mr. J. T. Tomblin
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24	Mr. B. W. Wolfe, SPT
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War Office

29-32 Scientific Adviser to the Army Council (Mr. P. Johnson) and for Mr. E. R. Drake Seager

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33 Scientific Adviser (Mr. S. Scott Hall)

Ministry of Supply

34 Director General of Atomic Weapons (Mr. E. S. Jackson)

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35 Mr. V. H. B. Macklen

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